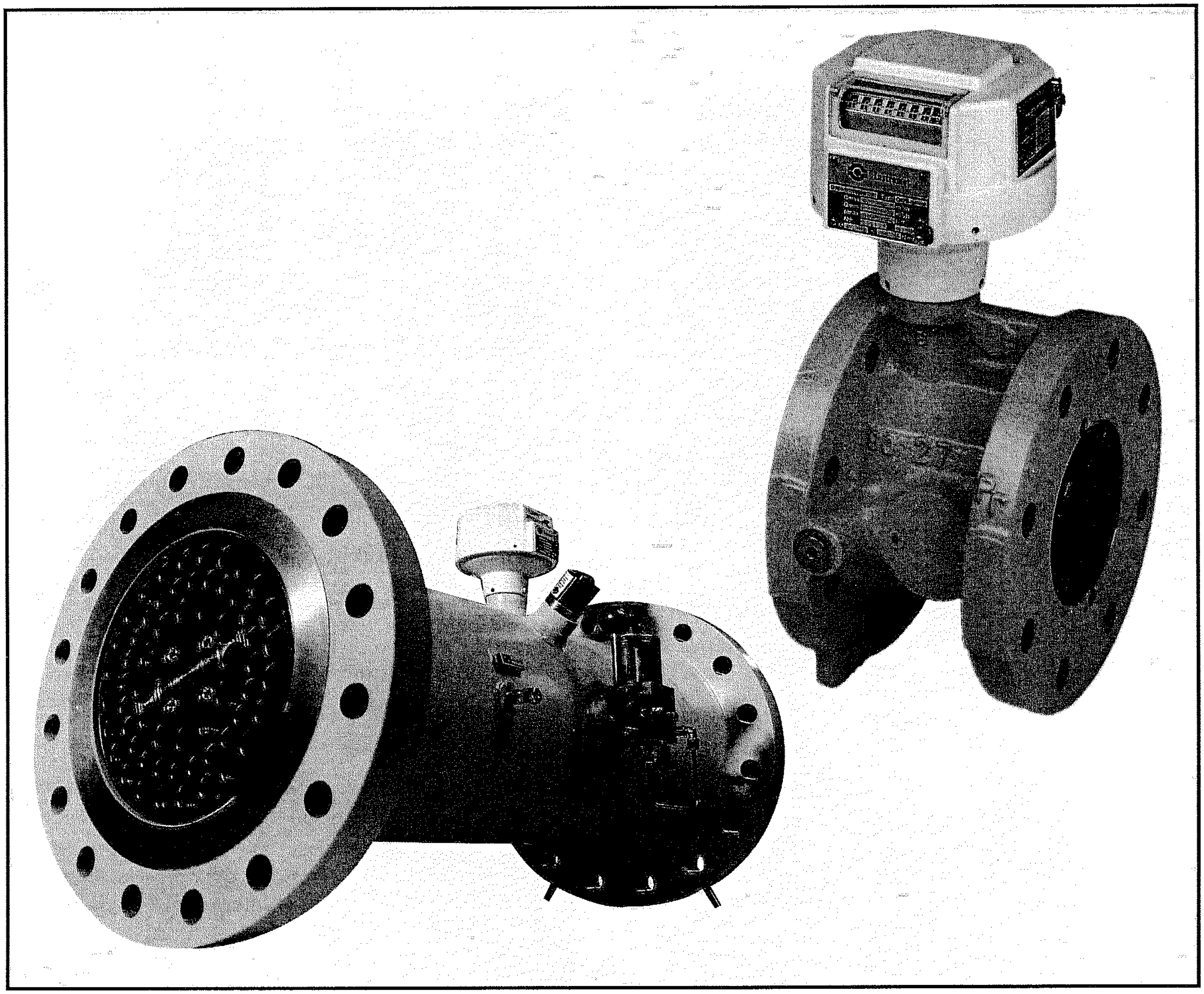
Instromet, Inc.

"X-XIC" & "Q-QIC" Gas Turbine Meters



Installation & Maintenance Instructions

Introduction

Instromet turbine meters are designed to measure gas in the vapour state. Proper application and routine maintenance of these meters will result in many years of satisfactory operation.

The following instructions generally comply with the recommendations contained in American Gas Association, Gas Measurement Committee Report # 7: "Measurement of Fuel Gas by Turbine Meters", (AGA Catalog No. XQO580).

On Receipt

Carefully examine the shipping container for any external damage before unpacking. Any evident damage should be reported to the carrier.

PLEASE BE SURE TO KEEP ALL DOCUMENTS THAT CAME WITH THE METER, SINCE THEY ARE REQUIRED FOR METER RECORDS.

After unpacking the meter, make sure its specifications comply with your order. Report any deviations to your **Instromet** representative.

Product Specifications

The flange dimensions of Instromet turbine meters conform to ANSI B16.1 and B16.5 standards. All meter bodies are hydrostatically tested at 1.5 times the maximum rated working pressure indicated on the meter identification plate.

Note: Meters must not be subjected to working pressures in excess of the indicated maximum working pressure.

Standard construction Instromet turbine meters are designed to operate at flowing gas temperatures between +14°F and +150°F and at ambient temperatures between -20°F and +165°F. Special materials are available for operation at different temperatures.

Instromet turbine meters may be overranged for short periods of time up to 20% in excess of their maximum rated capacities.

Installation

Turbine meters are basically velocity sensing devices which derive volume by sensing the flow rate through the known cross-sectional area of the meter module housing. Accurate velocity sensing is essential to derive accurate volume measurement.

Ancillary devices in the measurement installation can cause flow disturbances which upset the normal velocity profile of the gas stream. Extensive tests with turbine meters at various flow rates and pressures have resulted in the definition of piping configurations which optimise measurement accuracy.

The most common installation configuration is In-Line. A minimum of ten (10) pipe diameters of straight pipe must be placed between any flow disturbing device (other than flow-throttling) and the inlet flange of the turbine meter. An additional eight (8) pipe diameters must be added between the meter inlet flange and any throttling device (regulator, control valve, etc.) installed upstream of the meter. Inlet piping must be of the same nominal diameter as the meter body.

Minor variations in piping ID caused by different wall thicknesses will not affect meter accuracy. In-line straightening vanes located four or five pipe diameters upstream of the meter are recommended.

NOMINAL IN-LINE DIMENSIONS (INCHES)

METER SIZE (inch)	FLANGE-TO-FLANGE (inches)
2"	5.906"
3"	4.724"
4"	5.906"
6"	6.890"
8"	7.874"
10"	14.764"
12"	17.717"
16"	23.622"
20"	29.528"
24"	35.433"
30"	44.291 "

Table 1

To ensure a proper velocity profile at the meter inlet, the two 90° turns into the inlet end of the meter run must be in the same plane. Elbows or tees can be used for the 90° turns. Reducing fittings may be used as long as the reduction at the inlet end does not exceed one nominal pipe size. Fitting sizes downstream from the meter are not critical, as long as the ID of the connection to the meter outlet flange is equal to the meter ID.

Note:

A. Pipe fabrication, welding, purging and hydrostatic testing *must be completed prior* to the installation of the turbine meter.

B. The installation of a by-pass around the meter run is recommended for all piping configurations.

C. Companion flanges at the meter inlet and outlet should be aligned concentrically. Gaskets should not protrude into the pipe.

D. The interior pipe wall should be of commercial roughness, with no protruding welds.

Vertical Installation

Specially constructed Instromet turbine meters are available for vertical installation. Please contact your **Instromet** representative if a vertical installation is being contemplated. Standard Instromet turbine meters should not be installed vertically.

Prover Connections

If low pressure, or critical flow, or transfer provers are considered to be used to prove turbine meters in the field, it is important to locate the prover connections in such a manner that the normal flow pattern through the meter is duplicated during the test. Tees equipped with blind flanges and 2" or 3" pipe plugs, positioned an appropriate number of pipe diameters upstream and downstream of the meter are commonly used for this purpose.

A 1/4" NPT pressure connection for instrumentation is located on each meter body. Temperature connections for sensors or recorders should be located within two pipe diameters downstream of the meter.

Blow-Down

A facility enabling the controlled venting of the meter to atmosphere should be provided. This facility should be located between the meter outlet flange and the downstream block valve.

> *NOTE: Over-sized blow-down facilities can produce velocities greatly in excess of maximum rated capacities and can lead to meters being damaged.*

As a rule of thumb, blow-down facilities should be sized at one-sixth of the meter size or smaller. For a quick reference, please consult the table below:

Blow-down Sizing

Meter Size	Blow-down size
2"	1/4"
3"	1/2"
4"	1/2"
6"	1"
8"	1"
10"	1"
12"	1"
16"	1 1/2"
20"	1 1/2"
24"	2"

Table 2

NOTE: When meters are installed in a meter house or building, blow-downs must be vented to a non-hazardous location.

Initial Start-Up (Refer to Figure 1)

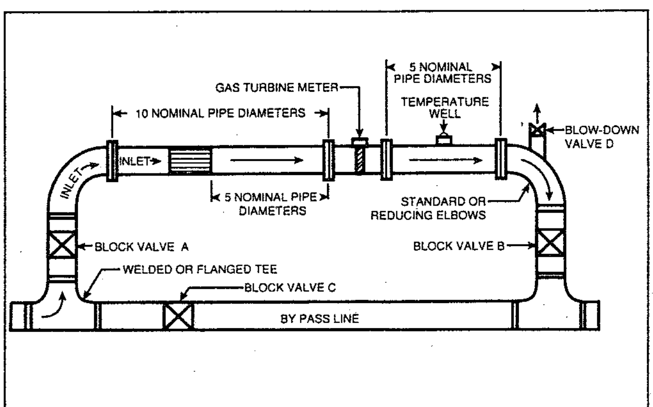


Figure 1

1. Valve C is open. Valves A, B and D are closed.
2. Slowly open valve A.
3. When the meter stops registering, slowly open valve B.
4. Slowly close valve C.

Note:

When commissioning turbine meters, care must be taken to pressurise the system very slowly, to avoid excessive gas velocities. These not only can damage the meter but may also cause foreign matter to be picked up and carried into the meter, thus causing additional damage.

If a large downstream piping system needs to be pressurised, it should always be brought up to pressure through the by-pass.

FILTERS and STRAINERS

If excessively dirty gas conditions are present or anticipated, a filter or strainer should be installed upstream of the inlet piping of the turbine meter.

Subjecting gas meters to solid "slugs" of liquid will result in inaccurate measurement and may destroy the meter. When significant amounts of liquids are expected to be present in the gas, a filter/separator is recommended and should be installed upstream of the inlet piping of the turbine meter.

Though some gas companies maintain stricter standards, filters, strainers and/or filter separators should at least be capable of removing all particles larger than 25 micron. For proper sizing of such filtration equipment, please consult the appropriate manufacturer(s).

Shut-Down (Refer to Figure 1)

1. Open valve C..
2. Slowly close valve B.
3. Slowly close valve A..
4. Carefully open valve D.

> **CAUTION**
> *All pressure in the meter run must be relieved to a non-hazardous location prior to disassembly of the meter.*

Re-Start

Follow the procedure outlined above for "Initial Start-Up".

> **NOTE**
> *Valves should be operated slowly to avoid shocking the meter. The higher the pressure, the more slowly the valves should be operated.*

In high pressure installations, a valved by-pass around the inlet block valve (valve "A", Fig. 1) is recommended. This is usually made up of 3/4" pipe with a needle valve, facilitating pressurising of the meter run without causing damage.

Once the full operating pressure has been reached, as evidenced by the lack of any further volume being registered on the meter index, the needle valve may be closed and Steps #2, #3 and #4 of the initial start-up procedure can be executed.

Note on By-Pass Lines

If a bleed-to-line pilot loaded pressure regulator is installed upstream of the meter, the control line must also be connected upstream of the meter. Installation of the control line downstream of the meter constitutes a by-pass which, at elevated pressures, will permit significant volumes of gas to by-pass the meter and not be registered.

Lubrication

Instromet turbine meters are furnished with integral oil pumps which permit the injection of oil into the bearings while the meters are operating. This feature greatly facilitates frequent flushing of the bearings, thereby evacuating any dirt which may have entered them.

In new installations, when construction dirt may be present in the piping, it is recommended to flush the bearings monthly.

When and if the gas is clean, flushing the bearings 2 to 3 times per year will suffice.

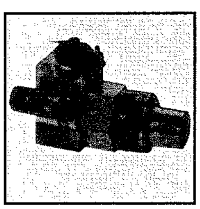
Recommended quantity of oil for proper flushing:

Meter Size	Lube Qty.	Meter Size	Lube Qty.
2"	1 cc = 10 strokes	10"	5 cc = 5 strokes
3"	1 cc = 10 strokes	12"	6 cc = 6 strokes
4"	2 cc = 4 strokes	16"	8 cc = 8 strokes
6"	3 cc = 6 strokes	20"	10 cc = 10 strokes
8"	4 cc = 8 strokes	24"	12 cc = 12 strokes

Table 3

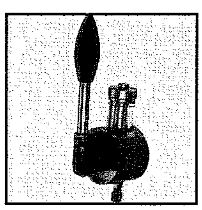
Oil Pump

All Instromet turbine gas meters are equipped with oil pumps. These can be operated while the meters are running. The oil pumps supplied with Instromet turbine meters have two functions: (1) to flush entrained dirt out of the bearings, thereby extending bearing life and (2) to provide lubrication. The following oil pumps are furnished with Instromet turbine meters;



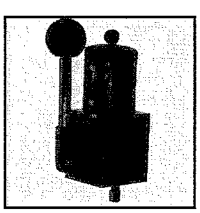
Push Button Oil Pump

Capacity: 0.1 cc per stroke
Standard on 2" and 3" ANSI 125, 150 and 300 meters.



Small Oil Pump

Capacity:0.5 cc per stroke
Standard on 2"& 3" ANSI 600 and all 4",6" and 8" meters.



Large Oil Pump

Capacity: 1.0 cc per stroke
Standard on 10" & 12" meters.
All meters ≥ 16" are furnished with 2 ea. large oil pumps.

Recommended Lubrication Oils

Instromet's turbine meter oil specification conforms to Military Specification MIL-L-6085A. This specification refers to a synthetic, di-ester based lubricating oil with an SAE viscosity number of 5W and containing no PCBs.
Recommended turbine meter lubrication oils and their sources of supply are as follows:

Oil	Source
Chemlube # 201	Ultra-Chem Corporation 1400 North Walnut Street Wilmington, DE 19899 Tel: 302-571-8520
Anderol 401-D	Tenneco Chemicals Turner Place, P.O. Box 365 Piscatawney, NJ 08854 Tel: 201-981-5000

Before Lubrication:

Make certain that the oil reservoir is clean and free of contaminants. Fill the reservoir with lubricant such as recommended above.

NOTE:
Always check that the oil pump functions properly by observing the oil level in the reservoir. If the oil level does not go down after pumping, the pump may be faulty and may need to be replaced.

Instrument Mounting

Instromet turbine meters are normally furnished with an 8-digit direct reading index and a low frequency reed switch pulse output. One or more optional mechanical and/or electronic outputs can be included. These outputs are primarily designed to operate in conjunction with electronic instrumentation. A special "Universal Mounting Plate" on the meter index is available. This enables the mounting of mechanically driven instruments, such as electronic volume correctors or recorders.

NOTE: TO ENSURE THAT PROVISIONS ARE MADE FOR THE MOUNTING PLATE AND MECHANICAL OUTPUT, IT IS IMPORTANT AT THE TIME OF ORDERING TO INDICATE THE INTENTION TO MOUNT METER DRIVEN INSTRUMENTS ON THE METER.

AGA Report # 7 states that accessory devices and instrumentation must be properly installed and maintained to prevent excessive torque loads on turbine meters. High torque loads will have a negative impact on meter accuracy and rangeability and will accelerate meter wear.

Do not install mechanical instruments on 2" or 3" Series "Q" turbine meters. These meters are only capable of driving electronic volume correctors such as the Instromet Series 999 and Series 555 EVCs.

Instromet turbine meters can also be used in conjunction with remote electronic instrumentation.
The mechanical outputs of Instromet turbine meters turn in a **clockwise** direction. One complete revolution represents a precisely known volume of gas at line conditions (Q/rev):

SERIES "Q" & "X" PERFORMANCE AND OUTPUT DATA

Size Inch	Qmax CFH	Qmin CFH	Range (base)	Q/rev CFH	δP at Qmax
2"	3,500	500	7 : 1	10	2.4" w.c.
3"	10,000	1,000	10 : 1	100	2.8" w.c.
4"	18,000	1,200	15 : 1	100	3.1" w.c.
6"	35,000	1,750	20 : 1	100	2.8" w.c.
8"	60,000	3,000	20 : 1	1000	1.2" w.c.
10"	100,000	5,000	20 : 1	1000	1.7" w.c.
12"	150,000	6,000	25 : 1	1000	1.7" w.c.
16"	250,000	10,000	25 : 1	1000	1.7" w.c.
20"	350,000	11,700	30 : 1	1000	1.7" w.c.
24"	600,000	20,000	30 : 1	1000	1.7" w.c.

Table 4

SERIES "QIC" & "XIC" PERFORMANCE AND OUTPUT DATA

Size Inch	Qmax CFH	Qmin CFH	Range (base)	Q/rev CFH	δP at Qmax
8"	100,000	5,000	20 : 1	1000	1.2" w.c.
10"	150,000	7,500	20 : 1	1000	1.7" w.c.
12"	250,000	10,000	25 : 1	1000	1.7" w.c.
16"	350,000	11,700	25 : 1	1000	1.7" w.c.
20"	600,000	20,000	30 : 1	1000	1.7" w.c.
24"	900,000	30,000	30 : 1	1000	1.7" w.c.

Table 5

Above δP data apply to natural gas with a sp.gr. of 0.6 (air = 1)

When installing meter driven instruments on Instromet turbine meters, make sure that the instrument drive direction is matched to the clockwise output from the index and to the correct value for Q/rev. Failure to do so may result in significant measurement errors and could damage the equipment.
When Instromet turbine meters are installed in the vertical position, a 90° goose-neck adapter is required to mount an instrument. This adapter must be ordered at the same time as the meter to ensure the proper gearing and supports.

NOTE: DO NOT DRIVE MORE THAN ONE INSTRUMENT AT THE SAME TIME. INSTALLING SUCH DEVICES MAY CAUSE SIGNIFICANT MEASUREMENT ERRORS DUE TO EXCESSIVE RETARDING TORQUE AND WILL ALSO LEAD TO DECREASED METER LIFE.

Periodic Inspection

Instromet turbine gas meters should be inspected periodically to ensure that all components are in good operating condition. The frequency of such inspections depends on the severity of the application: A meter installed outdoors, running at or near its maximum rated capacity, under high pressure and measuring contaminated gas, will need to be inspected more frequently than a meter installed indoors and operating under more benign conditions.
The recommended periodic inspection procedure is as follows **(please refer to attached Parts List):**

1. Closely examine the meter and ascertain it appears to be operating properly, i.e. the index moves smoothly, the meter runs quietly and does not vibrate.
2. Remove any instrument installed on the index and/or disconnect any electrical wiring leading to remote electronic instrumentation.
3. Remove the index cover by loosening the four (4) Allen screws (2t) around its base and removing the bottom seal screw (2e) of the index plate. The index cover (2k) can now be carefully lifted off.

   Note: If the index contains low andlor high frequency pulse outputs, a short wire harness will connect the connector in the index cover to a small printed circuit board in the index mechanism. This wire harness can be disconnected, using the plug&socket arrangement at the circuit board.

4. After gently lifting the index mechanism from its support, make sure that the small universal coupling (2f) connecting the follower magnet (3) to the index mechanism, does not fall on the ground.
5. The index mechanism can now be inspected. It should be clean and run freely. If necessary, clean any dirt from the mechanism and lubricate the bearings with a droplet of fine instrument oil.
6 Observe the movement of the follower magnet (3) at the bottom of the index base (2y). It should move smooth-ly. Lubricate the bearing in the follower magnet with a droplet of fine instrument oil.

NOTE:
AT THIS POINT THE METER IS STILL RUNNING AND THE LINE IS STILL UNDER PRESSURE.

7. If company practices or observations made during the foregoing inspection indicate the need to spin test the meter, the meter and meter run need to be depressurised. **Follow the previously defined Shut-Down procedure.**
8. **After all pressure inside the meter has been relieved,** proceed as follows:
   8.1 For 2' and 3' meters: Remove the entire meter from the line and visually inspect the meter and its interior. Remove any dirt or debris that may be present. Conduct a "Spin Test" following the below procedure.
   8.2 **For larger meters:** Remove all bolts from the inlet and outlet flanges of the meter, except the sets at the 5 or

7 o'clock position on the inlet and outlet flanges. Loosen these bolts sufficiently to permit the meter to be swivelled out of the line, using these two bolts as pivot points. **For larger, heavier meters, a crane or gantry will be required.** After the meter has been "swung" out of the line, it can be inspected for dirt or debris and the interior can be cleaned if necessary. Conduct a "Spin Test" following the below procedure.

9. Visually inspect the rotor and flow passages (including the inlet flow conditioner) for damage or obstructions. Any damaged part will have to be replaced.

Spin Testing the Meter

For a complete description of the Spin Test, its intent and purposes, please consult Section 9.3 of AGA Report #7. In addition, observe all company directives and practices which may apply.

1. With the meter in a horizontal position and shielding the mechanism from extraneous air currents, conduct the "Spin Test" following the following procedure:
   1.1. Preferably with a jet of air, forcibly set the rotor in motion as fast as possible. Listen for sounds that may indicate dry, dirty or faulty bearings.
   1.2. With the rotor turning at full speed, stop the air flow and at the same instant start timing the number of seconds it takes for the rotor to come to a complete stop. Record this time.
   1.3. Repeat this procedure three times and determine the average time in seconds so obtained.
   1.4. Compare the average spin time to the spin times in the table below. The average should be at least 65% of the spin times in the table.
   1.5. Watch the rotor stop. An abrupt stop indicates excessive friction in the bearings or the mechanism.
   1.6. Failure to achieve the specified spin time probably indicates a need to lubricate the rotor shaft bearings. After lubricating the bearings following the previously defined procedure, and prior to repeating the spin test, forcibly spin the rotor as outlined in 1.1 above for several minutes to clear excess lubricant.

Summary of Spin Times

The below spin times are approximate and were established at the factory with open outlet piping.

Meter Size in Inches	Turbine Rotor Material	Minimum Spin Time (sec.)	
		New	Used
2"	Delrin 45°	50	34
	Reinforced Delrin 45°	33	22
	Aluminum 45°	90	60
3"	Delrin 45°	80	55
	Reinforced Delrin 45°	70	45
	Aluminum 30°	130	85
	Aluminum 45°	140	90
4"	Delrin 45°	120	80
	Reinforced Delrin 45°	80	55
	Aluminum 30°	120	80
	Aluminum 45°	180	120
6"	Delrin 45°	210	140
	Reinforced Delrin 45°	170	110
	Aluminum 30°	380	250
	Aluminum 45°	410	270
	Alum. 45° 8mm bearings	210	140
8"	Aluminum 30°	320	210
	Aluminum 45°	330	215
10"	Aluminum 30°	250	165
	Aluminum 45°	250	165
12"	Aluminum 30°	390	255
	Aluminum 45°	390	255
16"	Aluminum 30°	490	320
	Aluminum 45°	490	320

Table 6

NOTE: In winter, when spin testing at low temperatures, a reduction in spin times can be expected, due to the temperature effect on the viscosity of oil.

Re-assembling the meter

If the inspection and spin test have revealed no need for further disassembly of the meter, proceed as follows, **(referring to attached Parts List):**

1. Return the meter to its former position in the meter run piping:
   1.1 **For 2" and 3" meters:** Position the meter between the inlet and outlet flanges, taking care that the meter is properly positioned for the direction of flow.
   1.2 **For larger meters:** Swing the meter back into the line, pivoting around the bolts left in the flanges.

Make sure that the gaskets are properly positioned and do not protrude into the meter run piping. Improperly positioned gaskets which protrude into the flow may cause measurement errors.

2. Tighten the flange bolts securely, following a crossover pattern to ensure equal torquing of the nuts.
3. Position the follower magnet (3) on its locating pin and check that it is properly seated.
4. Making sure that the (universal) coupling (2f) is firmly held by the nylon (gear) disk at the bottom of the index mechanism, carefully lower the index mechanism until the coupling engages the slot in the follower magnet.
5. Rotate the index mechanism until the index is facing in the desired direction.
6. Replace the index cover (2k). If applicable, reconnect the pulse output wiring harness to the socket on the printed circuit board in the index mechanism.
7. Tighten the four (4) Allen screws (2t) and replace and tighten the bottom seal screw (2e).
8. Replace any instrument which was mounted on the index. Ensure that the drive dog is properly engaged and that pressure and temperature connections are properly re-established. Reconnect wiring if applicable.
9. Re-pressurise the meter run, following the procedure outlined under "Initial Start-Up" above.
10. Following start-up, check the flange connections for leaks and make sure the index and any instruments mounted on it turn and register properly.

Proof Adjusting

Each Instromet turbine meter is individually calibrated prior to shipment, using some of the most sophisticated calibration equipment in the world.

Variations in the geometry of individual meter components result in some scatter in initial meter proofs. As a result of the calibration procedures, these individual meter proofs are all brought into a band as close as possible to an absolute 100% accuracy.

To accomplish these minor shifts in meter proofs, paired change gears are used. These are precision gears which, in combination, provide exact mathematical ratios. Various gear combinations are used to ensure that meter output shaft revolutions are accurate in engineering units.

A calibration certificate, which also details the change gears installed, is provided with each turbine meter. The multiplying action of the change gears does not alter the basic shape of the initial calibration curve. Instead, the en-tire curve moves vertically in precisely known increments.

The change gears (2b) are located inside the index mechanism. They are the two gears running in the vertical plane on the right side of the mechanism when facing the index odometer.

Because all Instromet turbine meters are calibrated under controlled laboratory conditions, field replacement or substitution of different combinations of change gears is usually not necessary, unless a critical part such as a rotor needs to be replaced.

Replacement meter modules are shipped together with their appropriate set of change gears. When changing meter modules in the field, it is important to keep the change gear sets with the modules to which they belong.

Change Gears

The change gears used in Instromet turbine meters have a fixed number of teeth on a fixed diameter wheel. The change gear combinations for all sizes of meters are handled by a total of 21 change gears of which the number of teeth varies from 47 to 67. As the position of the shaft on which the bottom change gear turns can be adjusted with respect to the position of the fixed shaft on which the top change gear turns, different diameter change gears can thus be accommodated.

The basic set of change gears, to which all other combinations relate, is the set **51/60,** resulting in a ratio of 0.85. This set represents two gears, one with 51 and the other with 60 teeth.

Under normal circumstances it will not be necessary to re-calibrate a turbine meter, unless a critical part such as a rotor needed to be replaced. Normal operating factors such as increased friction in the rotor shaft bearings can be corrected by lubrication (flushing the bearings clean of entrained dirt) or, if necessary, by bearing replacement.

It is necessary to maintain good meter calibration records. The initial calibration results are recorded in a calibration certificate (curve) which is shipped with each meter. These original data, together with any subsequent calibration and/or spin-time data for each individual meter should be kept on file.

Should it become necessary to substitute a different set of change gears for those originally supplied with a meter, please consult the table below to select the proper set. An example is given.

CHANGE GEAR SETS
Basic Set: 0.00% = 51/60 = Ratio 0.85

Proof	Gears	Ratio	Proof	Gears	Ratio
-0.18%	56/66	0.8484849	+0.29%	52/61	0.8534590
-0.30%	50/59	0.8474576	+0.57%	53/62	0.8548387
-0.45%	55/65	0.8461539	+0.83%	54/63	0.8571429
-0.61%	49/58	0.8448276	+1.09%	55/64	0.8593750
-0.74%	54/64	0.8437500	+1.12%	49/57	0.8596491
-0.94%	48/57	0.8421053	+1.34%	56/65	0.8615385
-1.04%	53/63	0.8412698	+1.40%	50/58	0.8620690
-1.35%	52/62	0.8387097	+1.58%	57/66	0.8636364
-1.67%	61/61	0.8360656	+1.67%	51/59	0.8644068
-1.70%	56/67	0.8358209	+1.92%	52/60	0.8666667
-2.00%	50/60	0.8333333	+2.19%	53/61	0.8688525
-2.31%	54/65	0.8307692	+2.41%	54/62	0.8709677
-2.35%	49/59	0.8305085	+2.64%	55/63	0.8730159
-2.64%	53/64	0.8281250	+2.86%	56/64	0.8750000
-2.71%	48/58	0.8275862	+3.07%	57/65	0.8769231
-2.98%	52/63	0.8253968	+3.10%	50/57	0.8771930
-3.09%	47/57	0.8245614	+3.33%	51/58	0.8793104
-3.33%	51/62	0.8225807	+3.56%	52/59	0.8813559
-3.55%	55/67	0.8208955	+3.77%	53/60	0.8833333
-3.70%	50/61	0.8196721	+3.98%	54/61	0.8852459
-3.89%	54/66	0.8181818	+4.18%	55/62	0.8870968
-4.08%	49/60	0.8166667	+4.38%	56/63	0.8888889
-4.25%	53/65	0.8153846	+4.56%	57/64	0.8906250
-4.48%	48/59	0.8135593	+4.80%	50/56	0.8928571
-4.62%	52/64	0.8125000	+5.00%	51/57	0.8947368
-4.89%	47/58	0.8103448	+5.19%	52/58	0.8965517
-5.00%	51/63	0.8095238	+5.38%	53/59	0.8983051
-5.40%	50/62	0.8064516	+5.56%	54/60	0.9000000
-5.46%	64/67	0.8059702	+5.73%	55/61	0.9016392
-5.85%	53/66	0.8030303	+5.89%	56/62	0.9032258
-6.25%	52/65	0.8000000	+6.05%	57/63	0.9047619
-6.67%	51/64	0.7968750	+6.21%	58/64	0.9062500
-6.70%	47/59	0.7966102	+6.50%	50/55	0.9090909
-7.10%	50/63	0.7936508	+6.67%	51/56	0.9107143
-7.45%	53/67	0.7910448	+6.83%	52/57	0.9122807
-7.55%	49/62	0.7903226	+6.98%	53/58	0.9137931
-7.88%	52/66	0.7878788	+7.13%	54/59	0.9152542
-8.02%	48/61	0.7868853	+7.27%	55/60	0.9166667
-8.33%	51/65	0.7846154	+7.41%	56/61	0.9180328
-8.51%	47/60	0.7833333	+7.54%	57/62	0.9193548
-8.80%	50/64	0.7812500	+7.67%	58/63	0.9206349

Table 7

The basic set of change gears (51/60) was arbitrarily chosen as a mid-point. Not every size meter has its calibration results scatter around this mid-point. The calibration results of each size meter scatter around some point somewhere in the above table.

Example 1:

A typical 3" Instromet turbine meter is supplied with a set of change gears 53/61. After repairing and re-calibrating this meter against an accurate reference standard, the meter is shown to be 0.85% slow.

This means that, as far as the reference standard is concerned, the meter must be made to run as near as possible 0.85% faster.

In the change gear list we find that the set 53/61 = +2.19% compared to the basic ratio (51/60). Hence, if we want this meter to register faster, we need a set of gears as close as possible to +2.19 + 0.85 = +3.04, i.e. a gear set that is +3.04% compared to the basic ratio.

Looking in the list, we see that the set of gears nearest to that ratio is 57/65 = +3.07%. When substituting this set of gears, we have set the meter approximately +0.03% faster than the standard.

Change Gears vs Pulse Outputs

It is important to remember on which side of the change gears pulses are being generated. Within Instromet turbine meters, it is possible to generate three distinct types of output pulses:

1. **Low frequency pulses.** These are produced by the closure of a simple reed switch in the index. A wheel containing a magnet runs past this reed switch, causing it to close. The magnet makes one revolution per revolution of the first index wheel, i.e. the reed switch produces one (1) pulse per 10, 100 or 1000 ft^3. As the magnet is located behind the change gears, where the meter is adjusted to for maximum accuracy, the low frequency pulse output will be of equal accuracy as the meter itself.

2. **Medium and High Frequency pulses.** The meter is also capable of producing two other types pulses:

2.1 **Medium frequency pulses** from a slot sensor in the index. A "slotted" disk inside the index, turning at the same RPM as the follower magnet, runs through a "slot" in an inductive proximity sensor. The disk contains 29 metal "vanes". As a result, one revolution of the slotted disk produces 29 pulses. The pulse output from this type pulser can go as high as 260 Hz at the maximum capacity of the meter. Since these pulses are produced ahead of the change gears, the meter calibration sheet will also indicate the exact number of such pulses per cubic foot. This means that when another set of change gears is substituted, the new number of pulses per cubic foot has to be calculated.

Example 2:

In the earlier example, it was established during the initial calibration that the 3" meter produced 70.549 pulses per ft^3. Later, during the re-calibration, it was determined that the meter ran 0.85% slow.

To "speed up" the pulse output, we now need to modify 70.549 to raise it 0.85% (57/65) and also allow for the offset from the basic ratio (53/61), i.e. 70.549 x 53/61 x 65/57 = 69.8997 pulses per ft^3. As this is a meter with a Qmax of 10,000 CFH, the new pulse output will produce 10,000 X 69.8997 = 698,997 pulses per hour or 698,997 ÷ 3,600 = 194.166 Hz at Qmax.

2.2 **High Frequency** pulses from a proximity sensor (Reprox Probe) at the rotor. This generates the highest rate of pulses which can be produced from an Instromet turbine meter. For instance, at its rated Qmax the 3-inch meter in our "Example" will produce a pulse frequency of over 2,000 Hz (pulses-per-second) from the Reprox Probe at its rotor or at the reference disk. It is obvious that the initially certified pulse ratio will need to be re-calculated if, upon subsequent re-calibration, it is decided to substitute a different set of change gears.

Pulse Data Series "Q" and "QIC"

Meter Size Q & X-Series	Qmax (CFH)	# Rotor Blades	Hz from Rotor	Hz Slot Sensor	1 LF Pulse =ft³
2"	3,500	12	2,577	213	10
3"	10,000	12	2,085	167	100
4"	18,000	16	2,297	204	100
6"	35,000	20	1,799	229	100
8"	60,000	20	1,187	87	1,000
8"	100,000	20	1,012	74	1,000
10"	100,000	24	1,316	136	1,000
10" IC	150,000	24	1,180	125	1,000
12"	150,000	24	1,226	75	1,000
12" IC	250,000	24	1,195	73	1,000
16"	250,000	24	1,095	268	1,000
16" IC	350,000	24	871	213	1,000
20"	350,000	24	871	213	1,000
20" IC	600,000	24	806	197	1,000
24"	600,000	24	702	75	1,000
24" IC	900,000	24	634	67	1,000

Table 8

Shaded areas contain approximate values.
Exact values are determined during calibration.

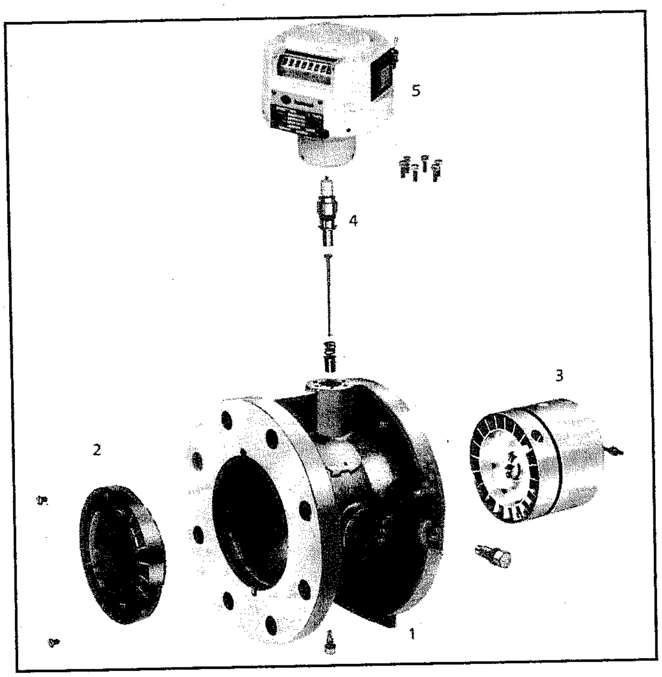


Figure 2

General Parts List

(Refer to Drawing Figure 3 of these instructions).

The below parts list identifies the principal parts used in the assembly of all sizes Instromet turbine meters and can be used to order such parts, e.g. Part No. 2f of drawing Figure 3, identifies the universal coupling driving the index mechanism.

Item	Part Description
1.	**Meter Body**
1 a	Lifting Lugs
2.	**Index Head (complete)**
2a	Counter (odometer) assembly
2b	Change gears
2c	Name plate
2d	Worm gear
2e	Bottom seal screw
2f	Universal coupling
2h	Vent screw
2k	Index cover
2m	Pulser connector - internal
2n	Reed switch
2p	LF slot sensor
2r	Index head bearing (10 ea.)
2s	Gear Module
2t	Index set screw
2v	H F slot sensor
2w	HF Disc
2y	Index base
2z	Index fixation screw
3.	**Magnet Coupling Assembly**, consisting of Driver and Follower Magnets, Stainless Stee Separation Chamber, Bearings and O-Ring.
4.	**Coupling Shaft**
4a	Spring
4b	Bushing
5.	**Meter Module** (complete)
5a	Gear coupling shaft bearing
5b	Turbine Rotor Delrin 45°
	or Aluminum 45°
	or Aluminum 30°
5c	Main shaft bearing (thrust-HP) front
5d	Rotor fixation nut
5e	Main shaft
5f	Worm gear/gear assembly
5h	Bearing block
5k	Bearing block fixation screw
5m	Meter module housing
5n	External fixation screw
5p	Internal fixation screw
5r	Main shaft bearing - rear
5s	Reference disc (not used)
5t	Worm gear shaft bearing
5v	Coupling shaft gear assembly
6.	**Flow Conditioner**
6a	Retaining pin screw
6b	Retaining pin
6c	Flow conditioner support screw
6d	Flow conditioner retaining screw
7.	**Pr Point -** Pressure connection $^3/_4$" NPT
8.	**Rotor HF (Reprox) Pulse Probe**
8a	Fixation screw
9.	**Follower Disc HF Pulse Probe**
9a	Fixation screw

10.	**Oil Pump (3 sizes)**
10a	Fixation screw
10b	Oil pump connection nut
10c	Check valve
10d	Check valve connection nut

Table 9

NOTE: THE PARTS IDENTIFIED IN THIS PARTS LIST AND DRAWING FIGURE 3 IN THESE INSTRUCTIONS, **MAY** BE FOUND IN A METER. FOR EXAMPLE: IN 2" AND 3" METERS, THE INTERNAL MODULES ARE HELD IN PLACE BY BUSHING (4b) AND SPRING (4a) HOWEVER, INTERNAL (5p) OR EXTERNAL (5n) FIXATION BOLTS ARE NOT USED.

Complete Meter Disassembly

Please refer to drawing Figure 3 and the above general parts list.

The repair or replacement of all or part of the flow conditioner or meter module will necessitate re-calibration of the meter. Even with stringently maintained manufacturing tolerances, minute differences in the geometry of parts can cause error shifts which need to be corrected if optimal measurement accuracy is to be achieved.

The replacement of oil pumps, pulse generators and parts of the index has, in principle, no effect on the performance of the meter.

The following procedure is outlined primarily for the use by customers with a technical staff experienced in gas meter repair, and having available a facility to calibrate large capacity gas meters.

IT IS **NOT NECESSARY TO REMOVE THE METER** FROM THE LINE IF PARTS OTHER THAN THE FLOW CONDITIONER (6) OR (ANY PART OF) THE METER MODULE NEED TO BE REPLACED.

THE **METER NEEDS TO BE DEPRESSURISED** BUT CAN REMAIN IN THE LINE IF ANY OF THE FOLLOWING PARTS NEED TO BE REMOVED ANDIOR REPLACED:
1. THE INDEX HEAD ANDIOR THE MAGNET COUPLING.
2. A HIGH FREQUENCY REPROX PROBE.
3. AN OIL PUMP.

THE LINE MUST BE DE-PRESSURISED IF ANY PARTS INSIDE THE METER NEED TO BE CHANGED. IN THIS CASE THE METER MUST BE REMOVED FROM THE LINE. SEE SHUT-DOWN PROCEDURE OUTLINED ABOVE.

REPAIR PROCEDURE

1. Remove any instrument installed on the meter and/or disconnect any electrical wiring connected to remote electronic instrumentation.

2. Attach lifting device (crane, gantry) to the meter if the meter is equipped with lifting lugs (1a).

3. Disconnect the pressure sensing line, if connected to the Pr Point (7) on the meter.

4. Remove the flange bolts and lift the meter from the line. Carefully lower the meter to a clean working surface.

5. Inspect the interior of the meter for visible damage, foreign matter and/or the presence of excessive amounts of liquid.

6. Check if the turbine wheel spins smoothly, by setting the rotor in motion manually, with a jet of air or, in case of 2" and 3" meters, by blowing into the meter.

DISASSEMBLY OF THE INDEX HEAD (Item 2)

7. Remove lead seal and seal screw (2c)

8. Loosen set screws (2t). Loosening these screws enables the index to be rotated and face in any direction desired.

9. Remove the index cover (2k) and gear module (2s). If necessary, remove vent screw (2h) to avoid pulling against a vacuum.

10. If the index contains low and/or high frequency pulse outputs, a short wire harness will connect the connector in the index cover to a small printed circuit board in the index mechanism. This wire harness can be disconnected at the plug & socket of the pulser connector (2m).

At this stage of disassembly, the reed switch (2n) or slot sensor (2p or 2v) may be removed and replaced.

Note: When reassembling the meter, make sure that the small universal coupling (2f) fits in the slot on top of the follower magnet (3).

11. **AFTER CHECKING (AGAIN) THAT THE METER HAS INDEED BEEN PROPERLY DEPRESSURISED,** remove screws 2z. The index base (2y) can now be removed.

Note: When re-assembling, fasten seal screws (2z) with Loctite.

12. Lift out the stainless steel separation chamber of the magnet coupling and the driver magnet on top of the coupling shaft (4).

Note: When re-assembling the meter, put Vaseline on the O-ring seal of the magnet coupling separation chamber.

REMOVAL OF THE METER MODULE (Item 5)

13. Remove coupling shaft (4).

14. Remove spring (4a) and bushing (4b).

Note: When inserting the module into the body, apply Vaseline to prevent corrosion. Make sure that bushing (4b) fits securely into the recess on top of the meter module housing.

15. If applicable, remove the external fixation screws holding the meter module (5n, max. 3 ea.) and any internal fixation screws of the meter module (5p, max. 3 ea.).

NOTE: THE EXTERNAL FIXATION SCREWS ARE COVERED BY SEALING LEAD OR WAX, WHICH MUST BE REMOVED TO GAIN ACCESS TO THE SCREWS.

16. For 16" and larger meters, remove "Pr" Point (7).

17. Remove the lube check valve connection nut (10d) inside the meter and remove the lube check valve (10c). Make sure all lube line connections between the meter body and the internal are removed.

18. If applicable, remove fixation screws (8a and/or 9a) of the Reprox Probe(s) at the rotor and/or reference disc. Remove the probe(s). 21.

19. The complete meter module can now be removed by sliding it out of the outlet side of the meter body.

DISASSEMBLING THE METER MODULE (Item 5)

20. If applicable, remove the red sealing wax and the fixation screws of the bearing block (5k, max. 6 ea.).

21. Remove oil line and bearing block (5h)

22. Remove fixation nut (5d) and turbine rotor (5b). In some of the smaller diameter meters, the rotor is screwed onto the main shaft. To unscrew the rotor, insert a small pin (like a straightened-out paper clip) through the small hole in the side of the bearing block. This pin will slide through a small hole drilled through the shaft, thereby blocking the shaft and allowing the rotor to be removed.

23. Remove the bearing cover plate screws; the main bearings and shaft can now be removed. In some meters the worm wheel set screw also needs to be loosened.

REMOVAL OF THE FLOW CONDITIONER (Item 6).

The flow conditioner needs only to be removed if it has been damaged.

24. Where necessary, loosen the centering screws (6c, max. 3 ea.).

25. Remove screws 6a, 6b and 6d (maximum 3 ea.) In some meters the (plastic) flow conditioner is glued to the meter body and may have to be forced out. Doing so will damage the conditioner, so do this only if the conditioner is already damaged and needs to be replaced.

26. The conditioner slides out of the inlet side of the meter body.

RE-ASSEMBLING THE METER

Re-assembling the meter should be done in the reverse order of the above described disassembly procedure.

NOTE: ALL CONNECTIONS THROUGH THE METER BODY MUST BE SEALED AGAINST LEAKAGE WITH TEFLON TAPE AND/OR SEALING WITH LOCTITE (5n, 7, 10c and, where applicable, 6d).

NOTE: GAS COMPANIES GENERALLY SEAL METERS TO PREVENT TAMPERING BY UNAUTHORIZED INDIVIDUALS. AFTER REASSEMBLING THE METER, ALL SEALS WHICH WERE BROKEN AND/OR REMOVED, NEED TO BE REPLACED!!!

SUGGESTIONS FOR TROUBLE SHOOTING

1. Mechanical Problems

During operation, mechanical trouble may be diagnosed if any of the following is observed:

1.1 **Vibration** is felt. This may be an indication that the turbine rotor is loose or out of balance and quite possibly damaged.

1.2 **Irregular** movement of the index. This may indicate damage and/or excessive friction in the index gearing, and possibly also inside the meter module. Check the index first.

1.3 **Stopped index,** the index does not rotate. Check first that there is gas flowing. If there is, the cause may be as in 1.2 above.

1.4 **Noise.** Excessive (often grinding) noise usually indicates damage in the meter module. This is usually a sign the meter must be removed for repair.

NOTE: BEFORE PROCEEDING WITH THE REMOVAL OF THE METER, MAKE VERY SURE THAT THE TROUBLE IS NOT LOCATED IN THE INDEX AND CAN BE FIXED WITHOUT DEPRESSURISING THE METER RUN AND REMOVING THE METER FROM THE LINE.

2. Electronic Problems

All pulse outputs must be connected to **intrinsically safe circuitry** Using the **Instromet MK15-RPN-ExO/K11** isolating pulse pre-amplifier is highly recommended. This unit has been especially developed to operate with all pulse generating devices used in **Instromet** gas meters.
The MK15 is powered from a (customer supplied) 24VDC supply. It contains the appropriate safety barriers which render the circuit up to the meter intrinsically safe (Class 1, Division 1, Groups C and D hazardous areas). The MK15 isolating preamplifier is installed in the non-hazardous area, usually adjacent to the flow computer.
Most electrical signal problems are caused by the use of incompatible electronic devices such as the wrong type amplifiers, power supplies and/or safety barriers. Be sure to follow the wiring instructions supplied with the meter.
Check the pulse wiring for continuity, check that the polarity, pin connections, voltage and current levels are within specification.
If everything checks out in order, the pulse generating device has failed and will need to be replaced.

NOTE:
IMPROPER CONNECTIONS MAY CAUSE PULSE GENERATING DEVICES TO FAIL!!!

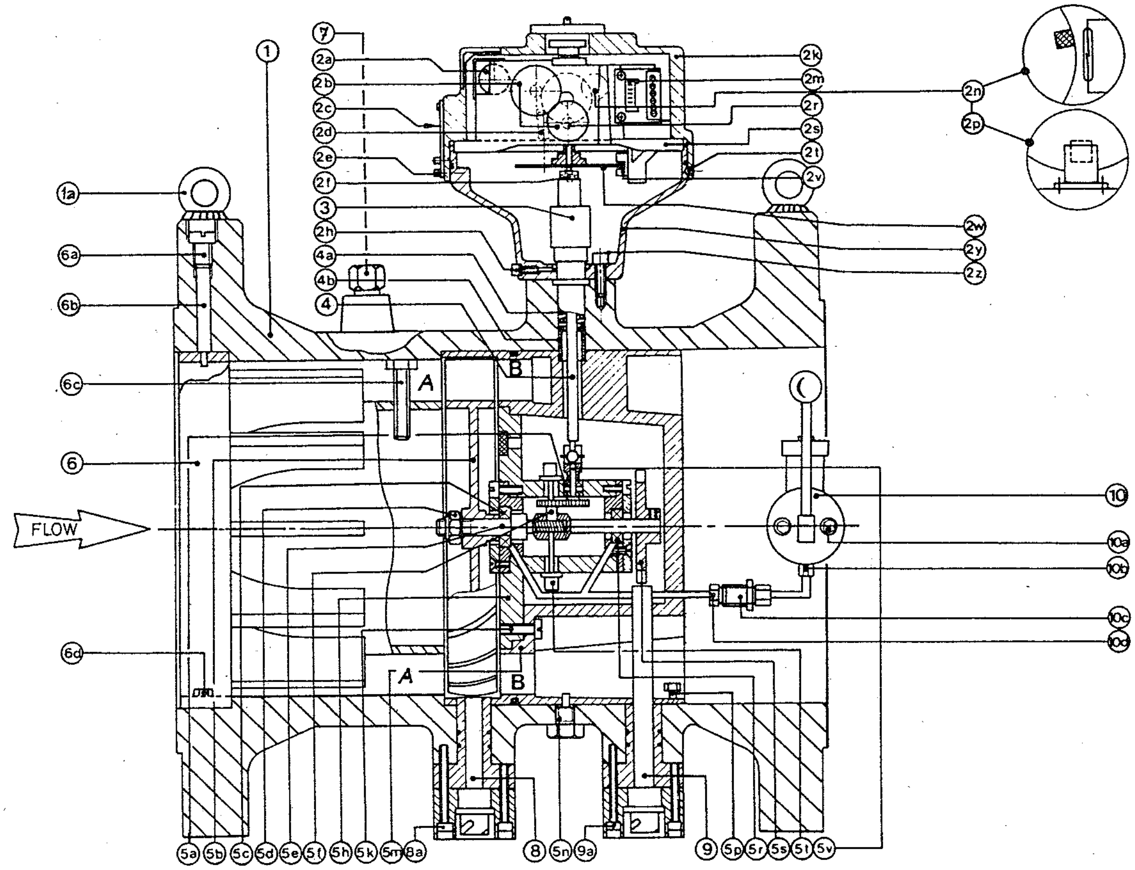
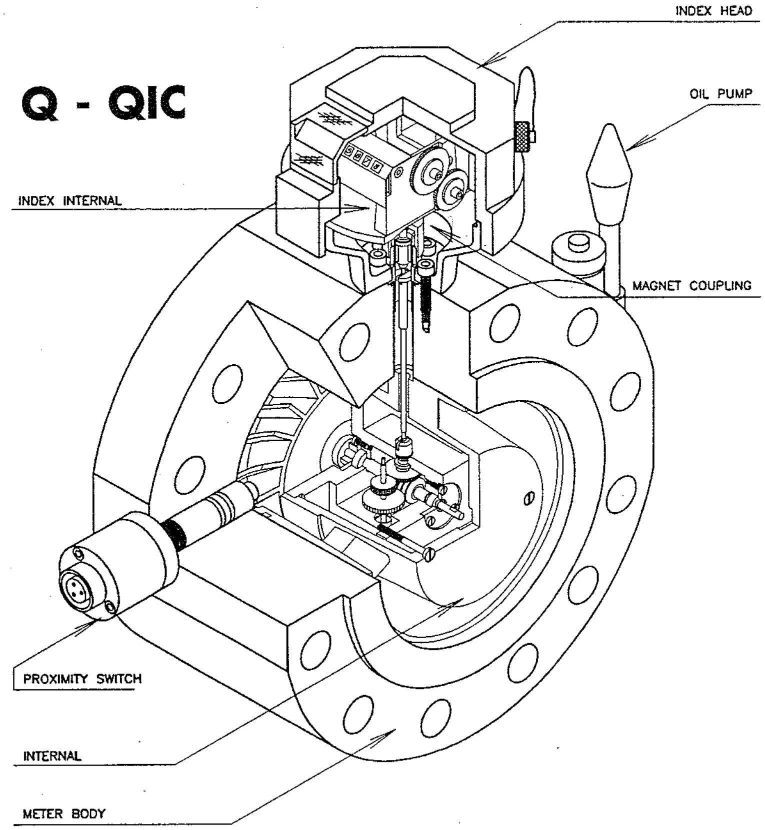
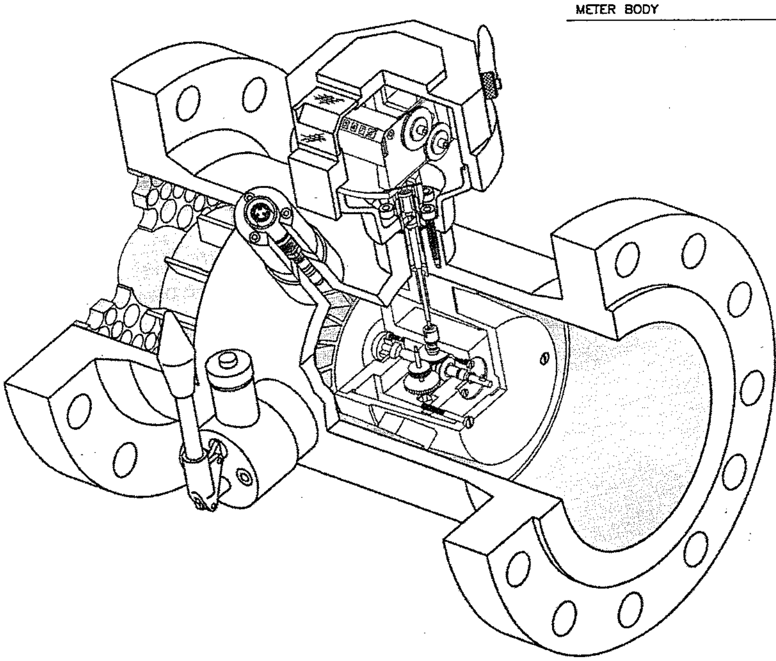


Figure 3

Q - QIC





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